20 March 1964
LEGiis-126

Chief, Office of Naval Research
Department of the Navy
Washington 25, D. C.

Attention: Code 414, [redacted] STAT

STAT Subject: Contract [redacted] Application of Perceptron Concepts to Photo-Interpretation

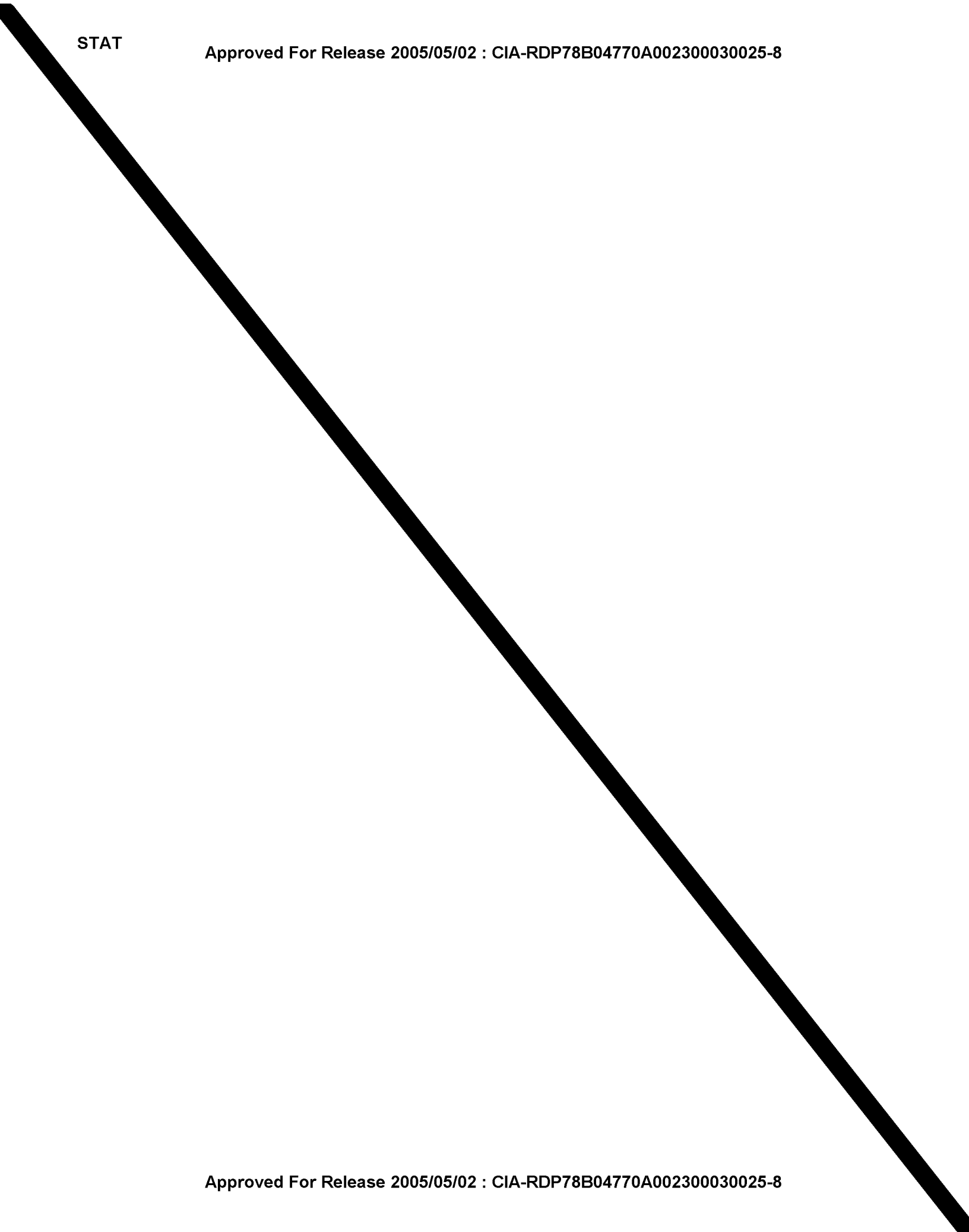
Enclosure: Nine Copies of Letter Report No. 25

Dear Sir:

We are enclosing nine copies of Letter Report No. 25 covering our technical progress under Contract [redacted] during February 1964. STAT

Of the contract estimated cost as amended by Modification #6 amounting to [redacted] we have expended [redacted] as of 1 March 1964, STAT STAT leaving a balance of [redacted] In terms of cumulative labor and indirect costs under the contract, the following is a summary as of 1 March 1964: STAT

[redacted]



Approved For Release 2005/05/02 : CIA-RDP78B04770A002300030025-8

[redacted] STAT

Letter Report No. 25

Investigation of Perceptron Applicability to Photo Interpretation

[redacted] STAT

Monthly Letter Report

for the month of February 1964

STAT

[redacted]

STAT [redacted]

STAT [redacted]

Report No. 23

Letter Report No. 25

Investigation of Perceptron Applicability to
Photo Interpretation
Monthly Letter Report
for the month of February 1964

1.0 INTRODUCTION

Project PICS is an investigation of the applicability of perceptrons to automation of certain parts of the photo interpretation task. Particular emphasis is placed on area and object recognition based upon properties derived from two-dimensional power spectra. Accordingly, effort is centered in the following major areas:

1) Theoretical and experimental evaluation of the properties which can be derived by optical spatial filtering.

2) Design and implementation of a recognition system based upon such properties.

3) Design of optical-electronic spatial filtering equipment.

4) Research based upon ideas whose immediate applicability cannot be stated, but of potential long-term benefit.

2.0 ACTIVITY AND ACCOMPLISHMENTS DURING FEBRUARY 1964

2.1 Property Evaluation

No work on spectral property evaluation was done during February.

2.2 Design of Optical-Electronic Spatial Filtering Apparatus

Basic experiments on a spatial filtering apparatus using a laser light source were described in last month's report. Appendix A of this report contains photographs taken at the time of these experiments but not prepared for printing early enough for inclusion with the January discussion. Captions with each set of photographs are self-explanatory.

The newly-designed experimental apparatus mentioned last month was essentially completed during February, and has been named the "Mark III Spatial Filter Recognition Apparatus". Figure 1 is a diagrammatic layout of the Mark III. The unique features of this system are (1) the original scene is scanned (mechanically in this case) and the two-dimensional power spectrum computed (optically) for an elemental area in the original scene and (2) categorization would depend upon logical combination of the power spectrum determinations. No definitive experiments have been performed as of the end of the reporting period, but preliminary trials indicate that:

a) the optical system is adequate

b) there is sufficient sensitivity

c) the distinctive frequency-plane signature of straight lines in the object plane is observable and automatically detectable.

The basic application of this apparatus is culture detection by measurement of straight line density. It is also a proving ground machine for other spectral properties expected of having utility for photo-interpretation.

2.3 Recognition Studies

Synthetically generated patterns which have been previously used for recognition studies were used in a new set of experiments to obtain the effects of the additional distortions produced by the isolation and standardization processes. These additional distortions are produced because the figures are often torn into several pieces by the noise generation process.

A 500 A-unit perceptron was trained to recognize all aircraft in a large sample of these patterns. A different set of 866 patterns was used to test its performance. There were 42 classification errors (4.8%) in this experiment. This is to be compared with no errors in a set of 720 patterns in previous experiments which did not use isolation and standardization.

Upon examination of the types of errors which were made, it seemed possible that inclusion of a scale-factor objective property would lower the error rate. An experiment showed that this was a false hope. Hindsight indicates that the patterns which were not aircraft were both smaller and larger than the aircraft, and thus a scale factor property could not aid linear separability.

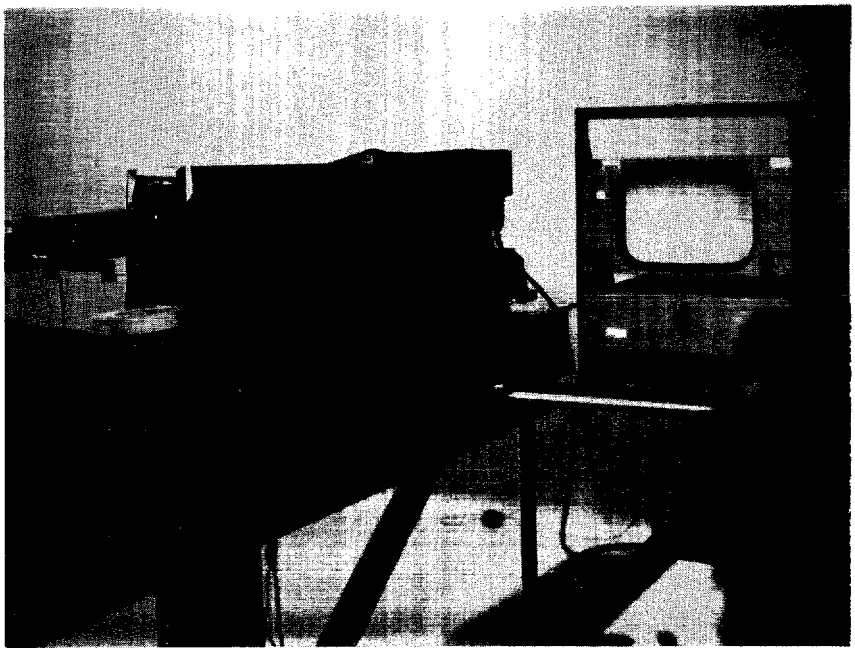
3.0 PLANS FOR MARCH 1964

Experiments in culture detection on the Mark III apparatus using synthetic and real photo segments will be attempted. This should provide the first significant test of spatial-filter-derived properties as recognition clues.

Some studies of perceptron training using only prototypes will be carried out.

4.0 REPORTS

No reports other than the regular monthly letter report were due or issued during February.



Experimental Set-up

The optical chain includes:

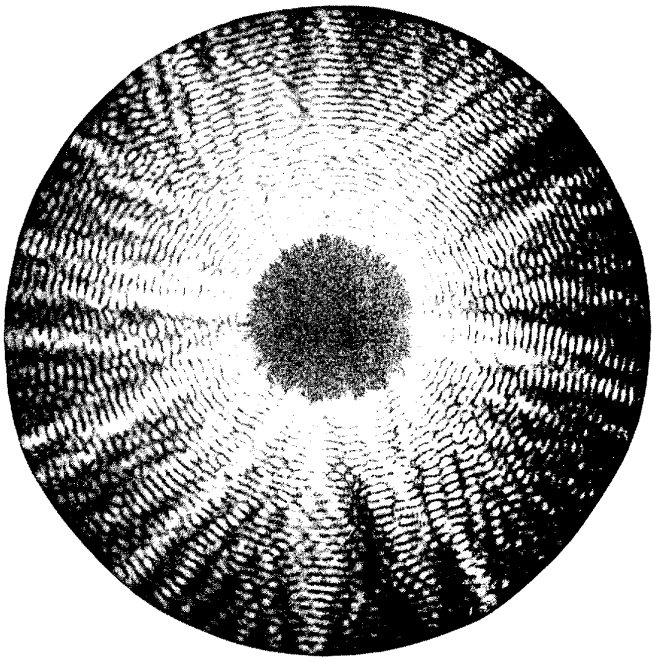
25X1

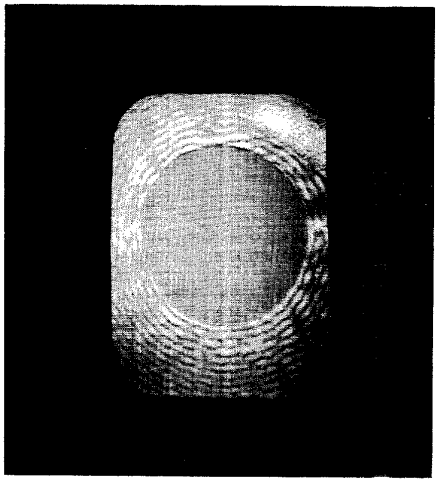
- [redacted] Model 115 gas laser (6328 Å) Hemispherical mode, 1.0 mw CW, diffraction limited, uniphase, spherical wavefront, beam diameter 3 mm.
- Object film or pinhole
- Lens
- Occluding filter
- Lens
- Vidicon and Monitor (Kintel) or film

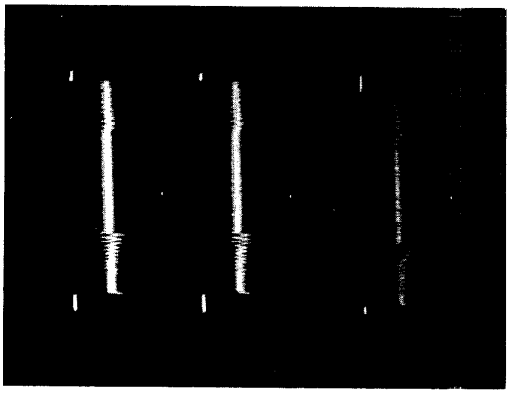
Contents

For these five objects: a pinhole, railroad yard, parking lot, field, and brush land; a 3 mm diameter laser beam illuminated a part of the object film.

Each page following contains (1) the spatial frequency plane photograph, (2) the monitor display of this plane, and (3) the video voltage signal for given lines of the monitor display.



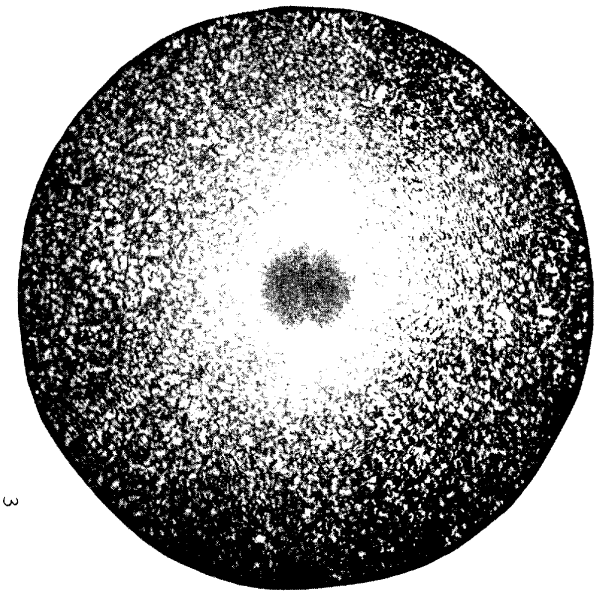


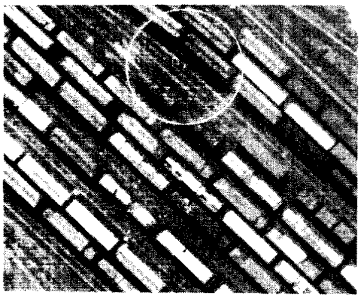


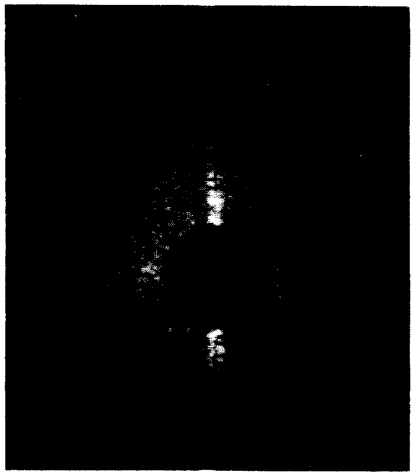
Airy rings of 1 mm pinhole

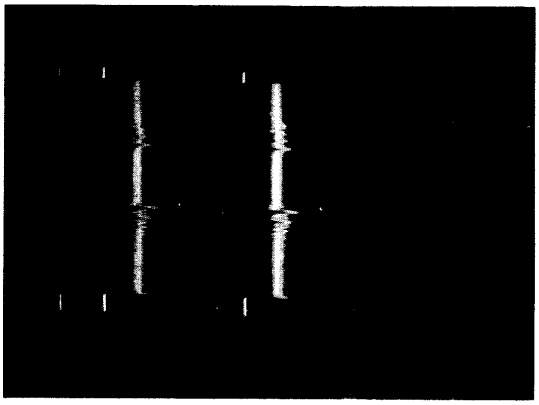
Bandpass occluding filter used in this case has central stop disc of 10.8 mm diameter and surrounding stop inside diameter of 35.5 mm; the passband is 12.6 cycles/mm to 46 cycles/mm.

All video signals shown are same center line of the raster taken at different exposures.





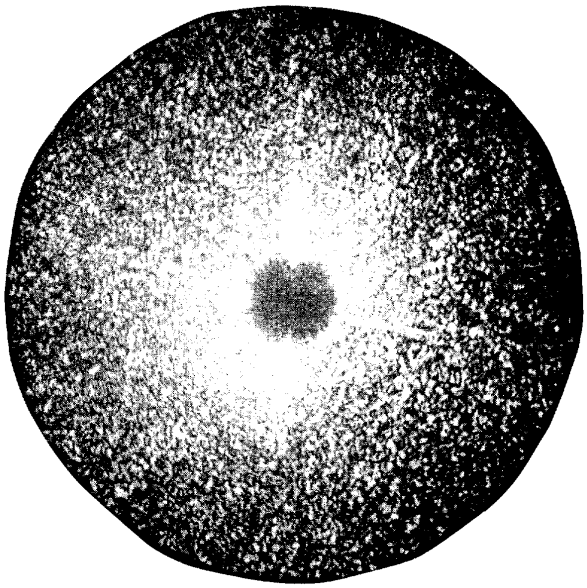


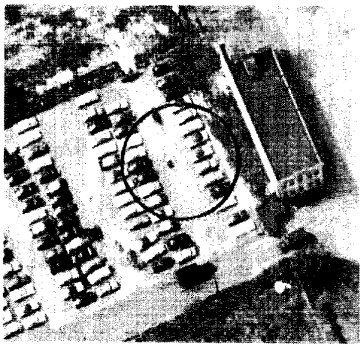


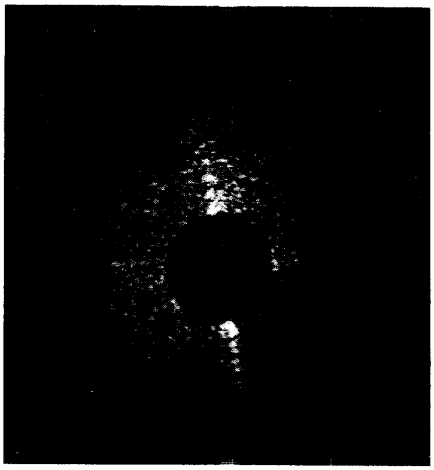
Rail yard objective film

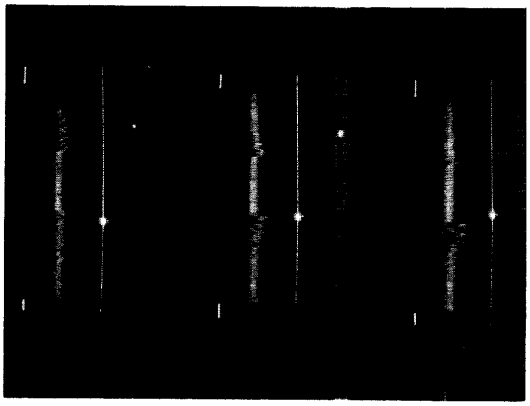
Bandpass occluding filter used here (and in all the following examples) has a central stop disc of 5.8 mm diameter and a surrounding stop inside diameter of 37 mm; the passband is 7.3 cycles/mm to 47 cycles/mm.

The video signals correspond to the raster center line.



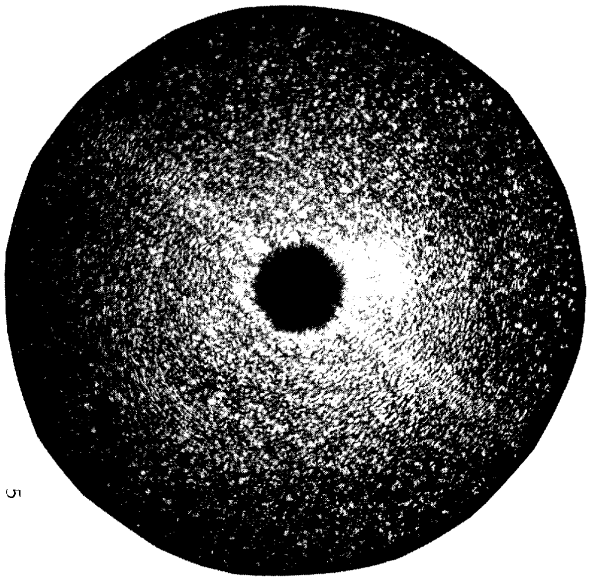


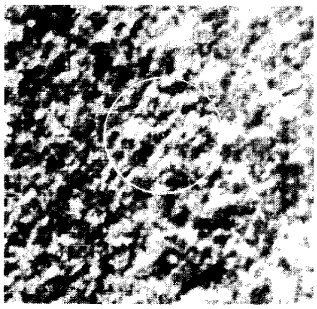


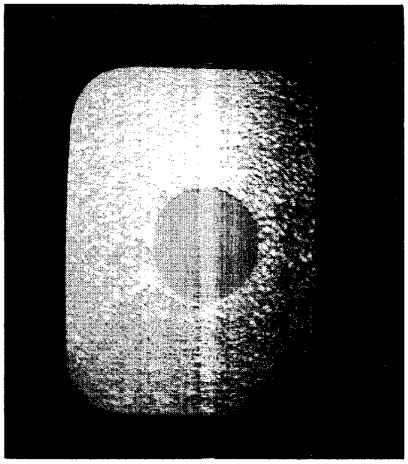


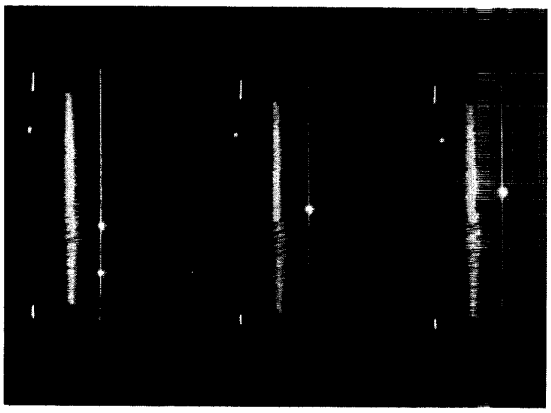
Parking lot objective film

The video signals are for three different horizontal lines near the raster center: about 25 TV lines below center, center line, and about 25 TV lines above center from print top-to-bottom.



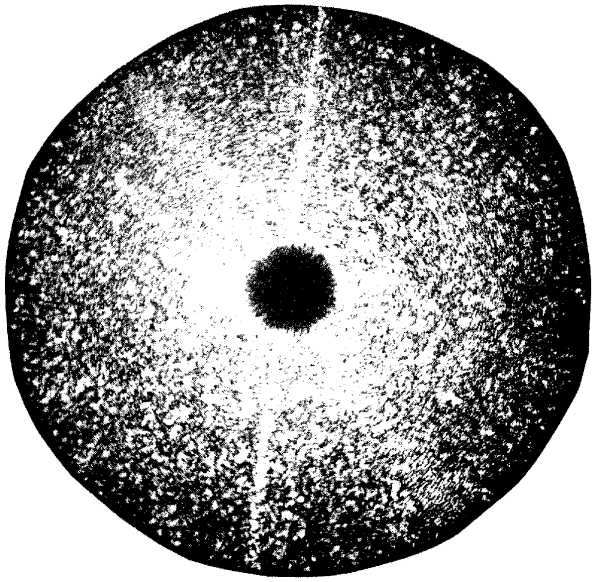


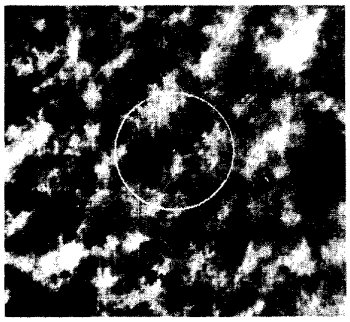


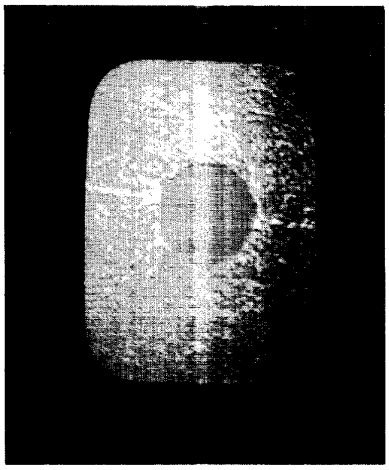


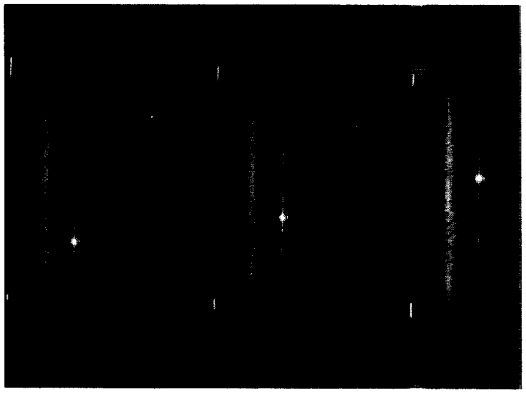
Field objective film

The video lines are, top to bottom, (1) through bottom one-quarter of occluding disc, (2) through center line, and (3) (unplanned) double exposure.





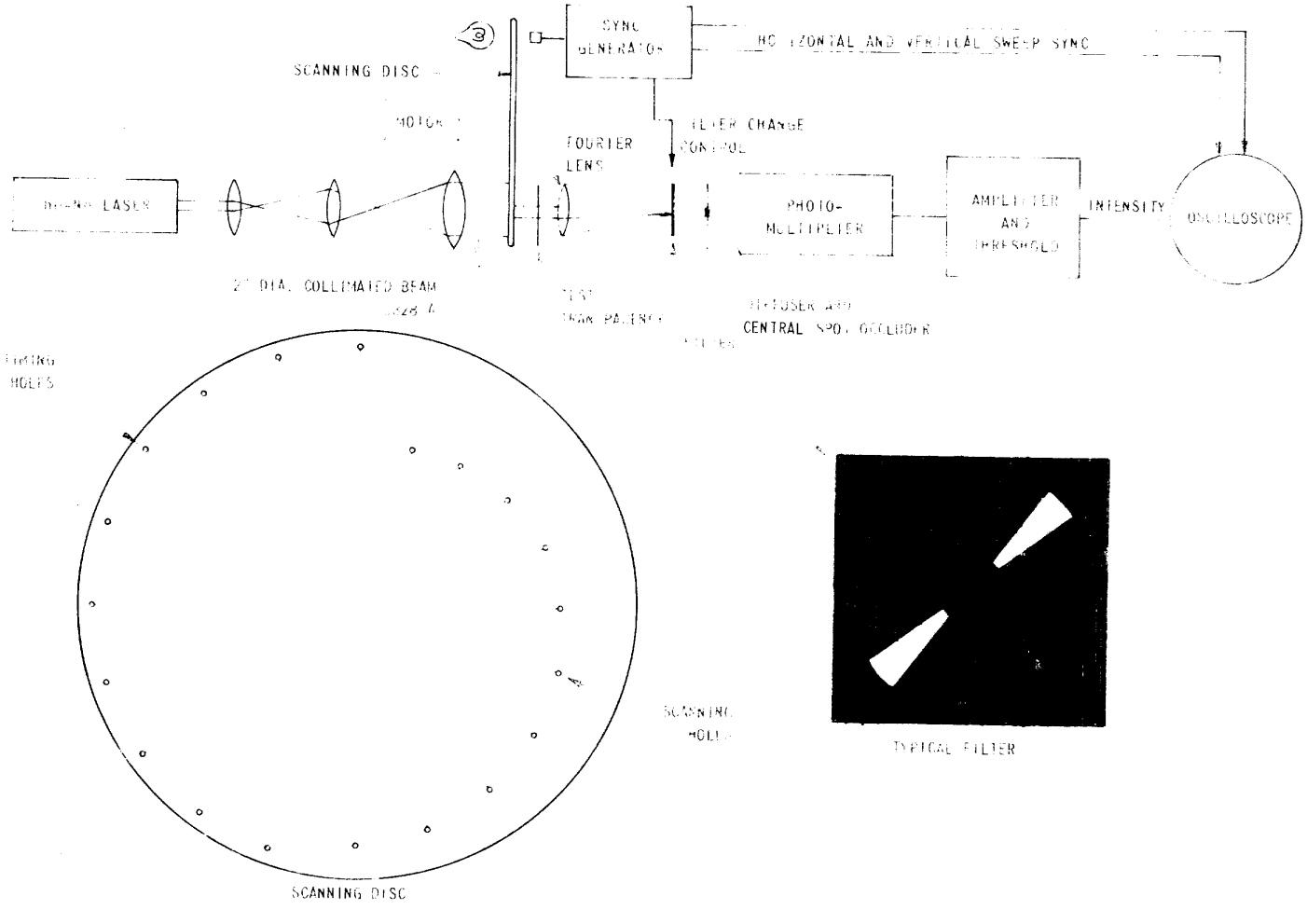




Brush land objective film

The monitor display near-vertical line may come from shadow edges apparent in the object film.

The three video lines include the raster center line and lines above and below the center by about 150 TV lines.



MARK III SPATIAL FILTER RECOGNITION AS APPLIED EXPERIMENTAL MODEL

STAT

24 January 1964
DTH-3:ghg

STAT

Dear Bob,

We are sorry that restrictions on use of your special address were misunderstood here. Until now it was our understanding that said address was for use only under very special circumstances. Hence, mailings from our Contracts Department to ONR, instead of mailings to your special address, carried your copies of Monthly Letter Progress Reports and forwarding letters containing financial statements. We have arranged for these items to be sent directly from the Computer Research Department to you, starting with the enclosures. [redacted] reported that copies of enclosures (1) and (2) sent to you via ONR had not yet reached you at the time of his January 15 visit.

STAT

I will be pleased to learn of any other ways we can expedite your receipt of results from the PICS program.

Very truly yours,

STAT

Enc. (1) Monthly Letter Progress Report No. 22 for month of November
(2) Letter to ONR from [redacted] dated 2 January 1964, Serial LEG:mb-1
(3) Monthly Letter Progress Report No. 23 for month of December
(4) Letter to ONR from [redacted] dated 24 January 1964, Serial LEG:mb-28

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Letter Report No. 22

Investigation of Perceptron Applicability to

Photo Interpretation

[redacted] STAT

Monthly Letter Report
for the month of November 1963

[redacted] STAT

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Report No. 22

Letter Report No. 22

Investigation of Perceptron Applicability to Photo Interpretation

Monthly Letter Report
for the month of November 1963

1.0 INTRODUCTION

Project PICS is an investigation of the applicability of perceptrons to automation of certain parts of the photo interpretation task. Particular emphasis is placed on area and object recognition based upon properties derived from two-dimensional power spectra. Accordingly, effort is centered in the following major areas:

1) Theoretical and experimental evaluation of the properties which can be derived by optical spatial filtering.

2) Design and implementation of a recognition system based upon such properties.

3) Design of optical-electronic spatial filtering equipment.

4) Research based upon ideas whose immediate applicability cannot be stated, but of potential long-term benefit.

2.0 ACTIVITY AND ACCOMPLISHMENTS DURING NOVEMBER 1963

2.1 Property Evaluation

Using the existing computer program for two-dimensional spatial filtering, the spectral power inside circles in the frequency plane was computed. Objects included a circle, a 2:1 aspect ratio ellipse of area equal to that of the circles, and a larger ellipse. The circle's spectral power as a function of pattern radius agreed (within a few percent) to the function for Fraunhofer diffraction shown in Figure 8.13 of Born and Wolf, Principle of Optics, New York, 1959.

Brightness normalization of the results is readily accomplished by dividing by the total spectral power. Area normalization is still in question. No obvious treatment of the data will result in distinguishing the ellipses from the circle on this basis alone.

2.2 Recognition Studies

No work directly pertaining to this objective was done during November.

2.3 Design of Optical-Electronic Spatial Filtering Apparatus

The continuing investigation of an optical-electronic spectrum analyzer (1) determined that analytical estimates of system light levels had lower confidence than direct scaling from similar experiments, (2) gathered existing components for a trial clean-room mock-up to be operated early in December, and (3) estimated development costs for the electronic equipment which would be required by the system.

The optical mock-up in the [redacted] clean room will use a mercury (5460 Å) source, a pinhole about 1/8 millimeter in diameter, collimator and object lenses, a liquid gate to hold the transparency, and a commercial closed circuit television system. Electronic processing equipment will not be set-up for this test. STAT

3.0 PLANS FOR DECEMBER 1963

3.1 Property Evaluation

No work on property evaluation is planned for December.

3.2 Recognition Studies

Previously used perceptron training techniques fail under certain circumstances. Investigation of a new method which is expected to resolve the "no solution" problem, and also remove ambiguous solutions, is planned for December.

3.3 Design of Optical-Electronic Spatial Filtering Apparatus

The following are expected to be accomplished during December 1963:

1) Operation of a system mock-up in the clean room using a closed circuit television system.
2) Determination of system parameters such as resolution and frequency scale from the above operation. Standard charts, half-tones, and gratings would be used in system calibration.
3) Assessment of proposed system design and modification, if required.

4.0 REPORTS

No reports other than the regular monthly letter report were due or issued in November.